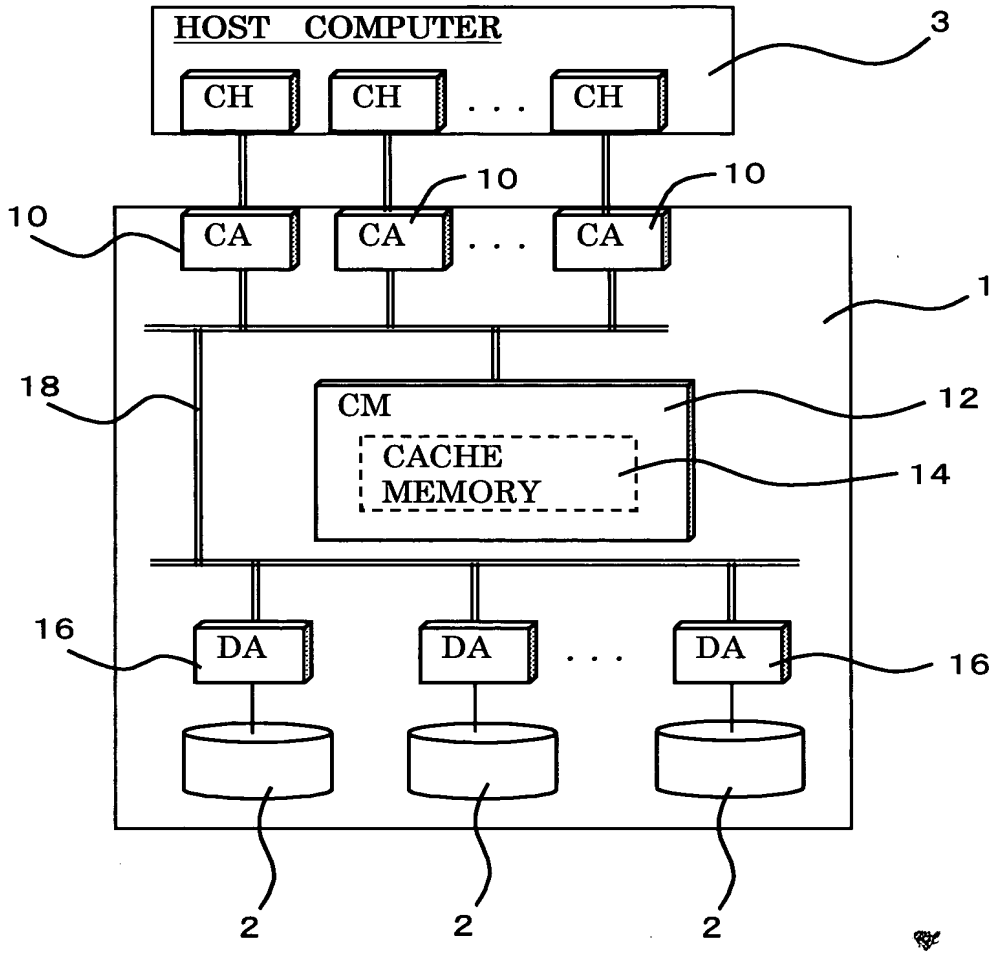
FIG. 1


HOST COMPUTER
3
CH
CH
. . .
CH
10
10
10
CA
CA
. . .
CA
1
18
CM
12
CACHE
MEMORY
14
16
DA
DA
. . .
DA
16
2
2
2

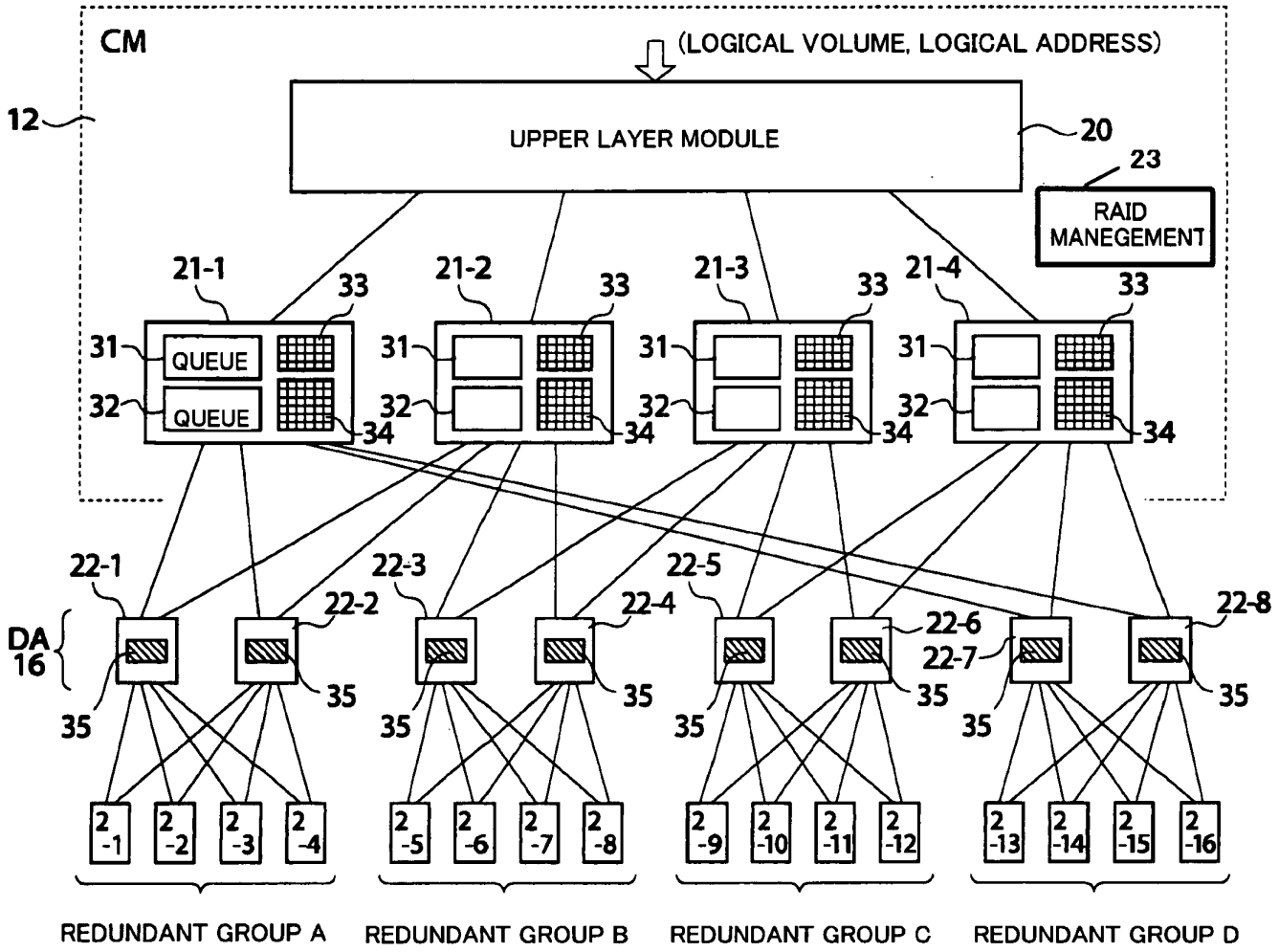

CM
(LOGICAL VOLUME, LOGICAL ADDRESS)
12
UPPER LAYER MODULE
20
23
RAID MANEGEMENT
21-1
21-2
21-3
21-4
33
31
32
34
QUEUE
QUEUE
22-1
22-2
22-3
22-4
22-5
22-6
22-7
22-8
DA 16
35
2-1
2-2
2-3
2-4
2-5
2-6
2-7
2-8
2-9
2-10
2-11
2-12
2-13
2-14
2-15
2-16
REDUNDANT GROUP A
REDUNDANT GROUP B
REDUNDANT GROUP C
REDUNDANT GROUP D

FIG. 3

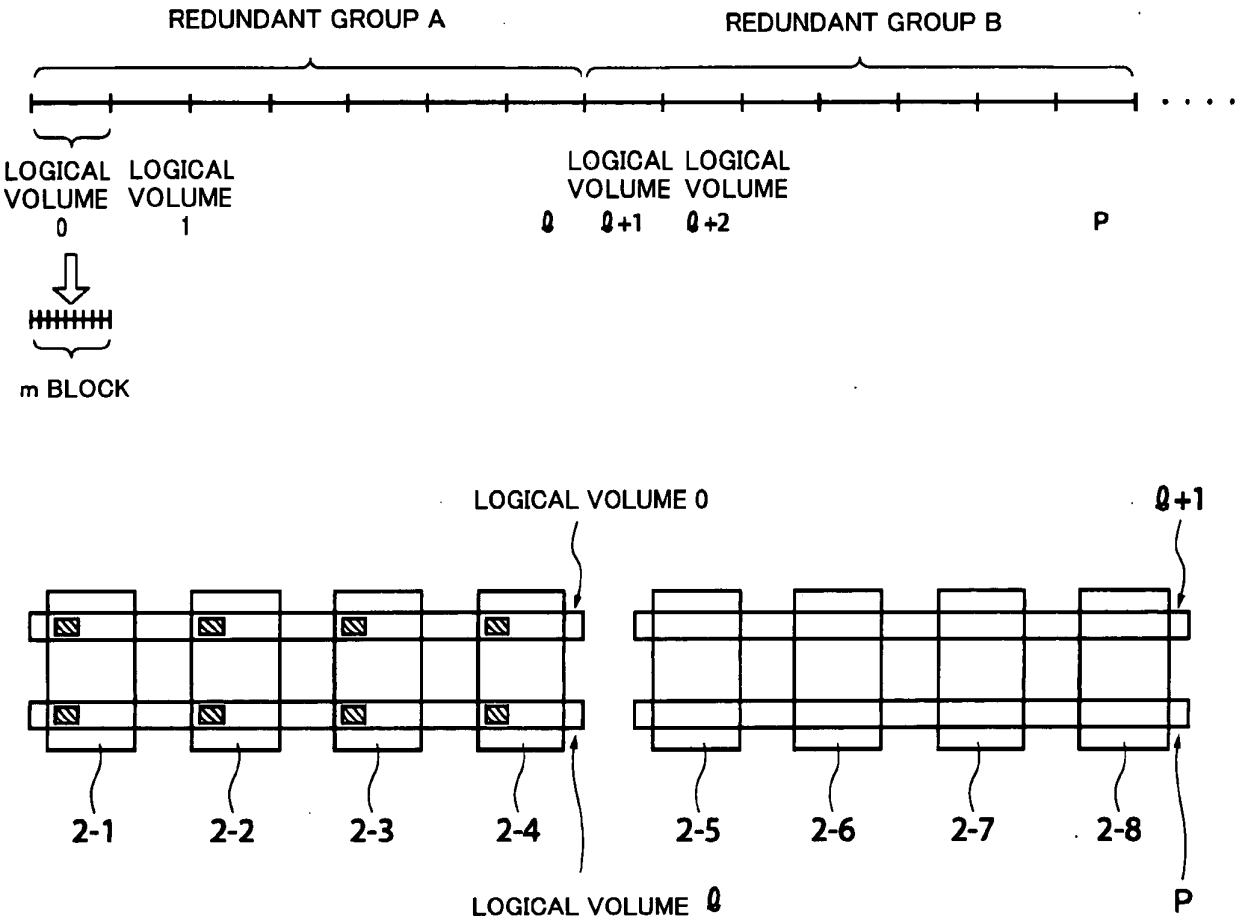

REDUNDANT GROUP A
REDUNDANT GROUP B
LOGICAL VOLUME 0
LOGICAL VOLUME 1
LOGICAL VOLUME Q
LOGICAL VOLUME Q+1
LOGICAL VOLUME Q+2
P
m BLOCK
LOGICAL VOLUME 0
Q+1
2-1
2-2
2-3
2-4
2-5
2-6
2-7
2-8
LOGICAL VOLUME Q
P

FIG. 4

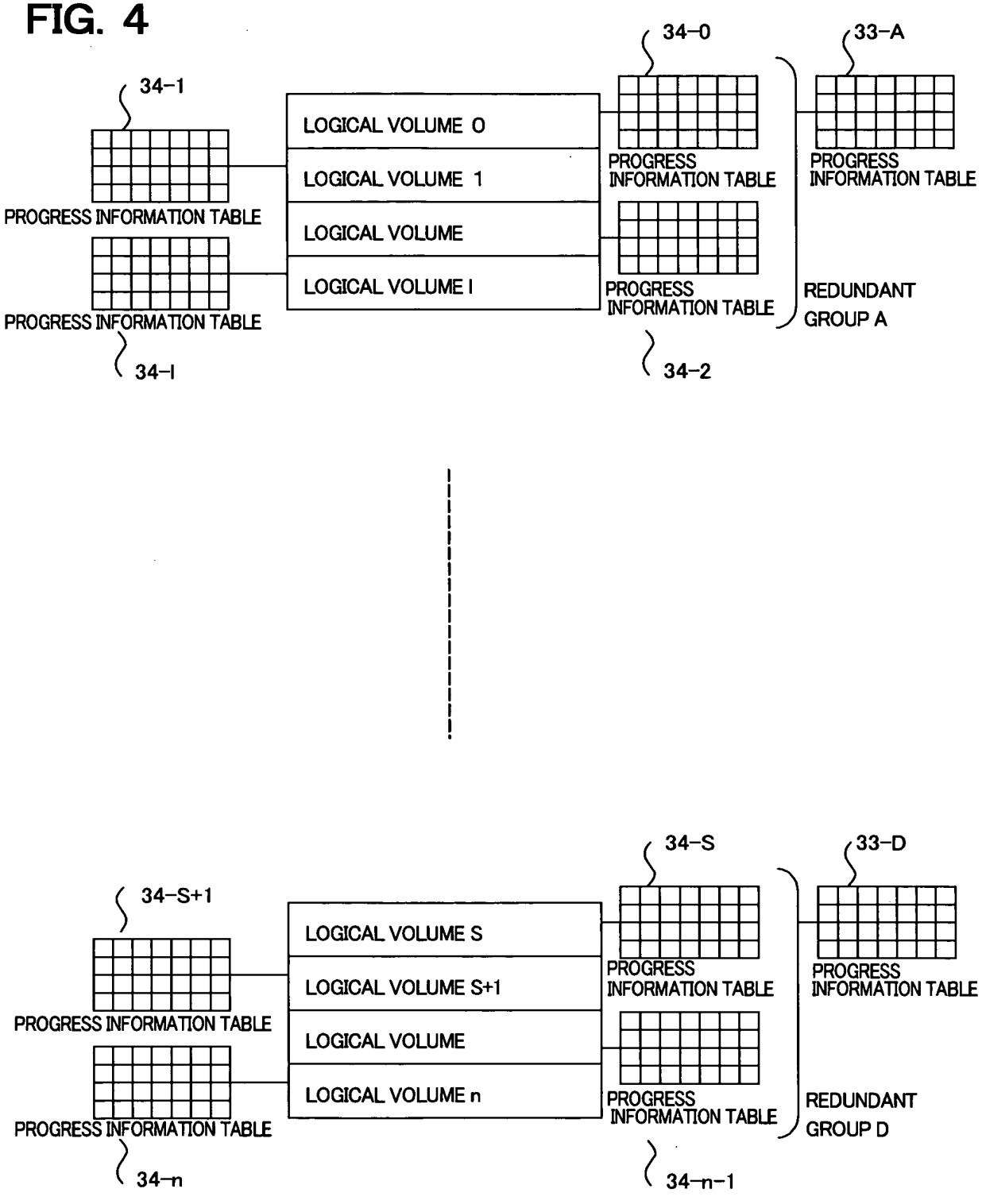

34-0
33-A
34-1
LOGICAL VOLUME 0
LOGICAL VOLUME 1
LOGICAL VOLUME
LOGICAL VOLUME I
PROGRESS INFORMATION TABLE
PROGRESS INFORMATION TABLE
PROGRESS INFORMATION TABLE
PROGRESS INFORMATION TABLE
PROGRESS INFORMATION TABLE
REDUNDANT GROUP A
34-I
34-2
34-S
33-D
34-S+1
LOGICAL VOLUME S
LOGICAL VOLUME S+1
LOGICAL VOLUME
LOGICAL VOLUME n
PROGRESS INFORMATION TABLE
PROGRESS INFORMATION TABLE
PROGRESS INFORMATION TABLE
PROGRESS INFORMATION TABLE
PROGRESS INFORMATION TABLE
REDUNDANT GROUP D
34-n
34-n-1

FIG. 5

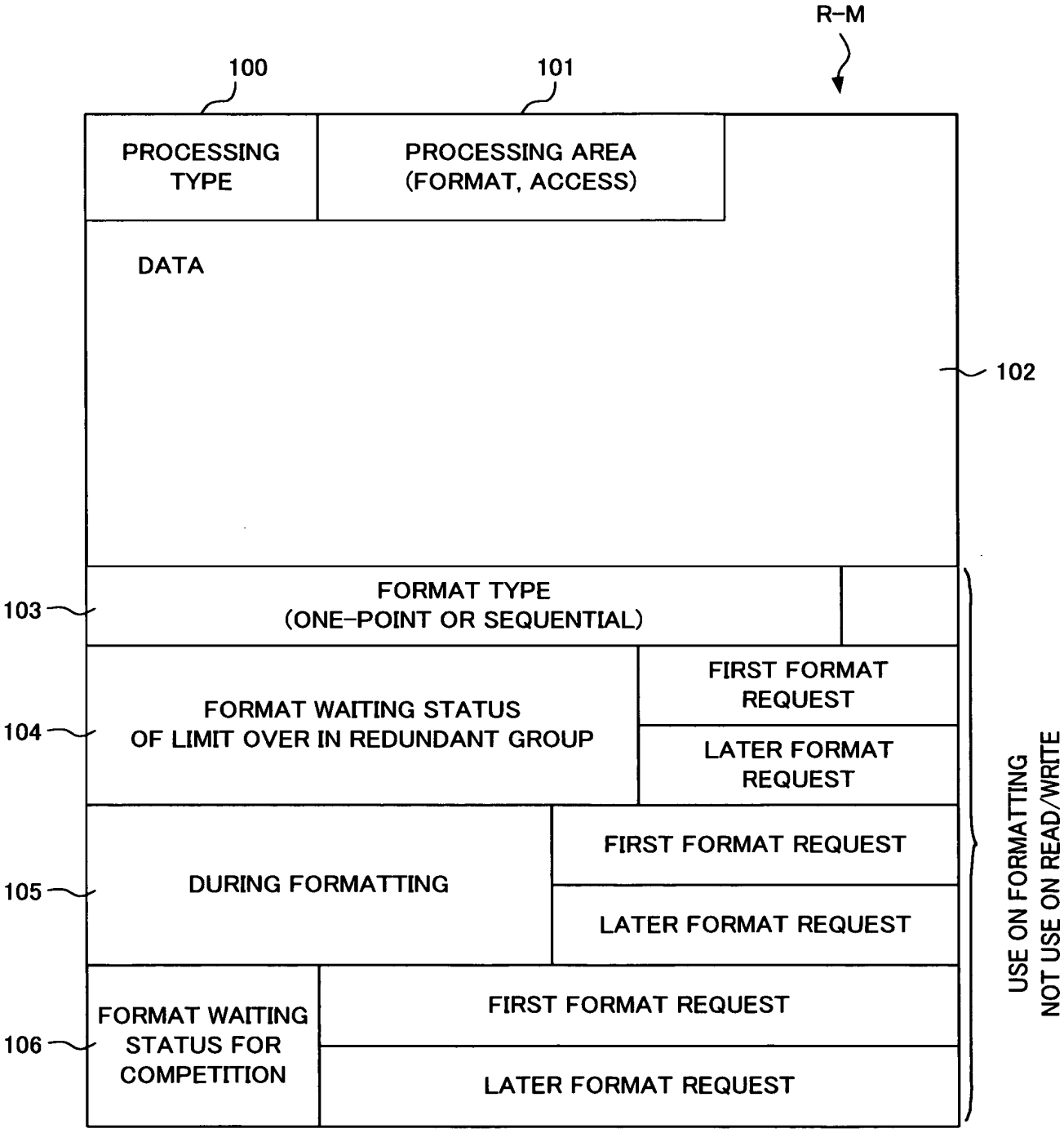

R-M
100
101
PROCESSING TYPE
PROCESSING AREA (FORMAT, ACCESS)
DATA
102
103
FORMAT TYPE (ONE-POINT OR SEQUENTIAL)
104
FORMAT WAITING STATUS OF LIMIT OVER IN REDUNDANT GROUP
FIRST FORMAT REQUEST
LATER FORMAT REQUEST
105
DURING FORMATTING
FIRST FORMAT REQUEST
LATER FORMAT REQUEST
106
FORMAT WAITING STATUS FOR COMPETITION
FIRST FORMAT REQUEST
LATER FORMAT REQUEST
USE ON FORMATTING
NOT USE ON READ/WRITE

FIG. 6

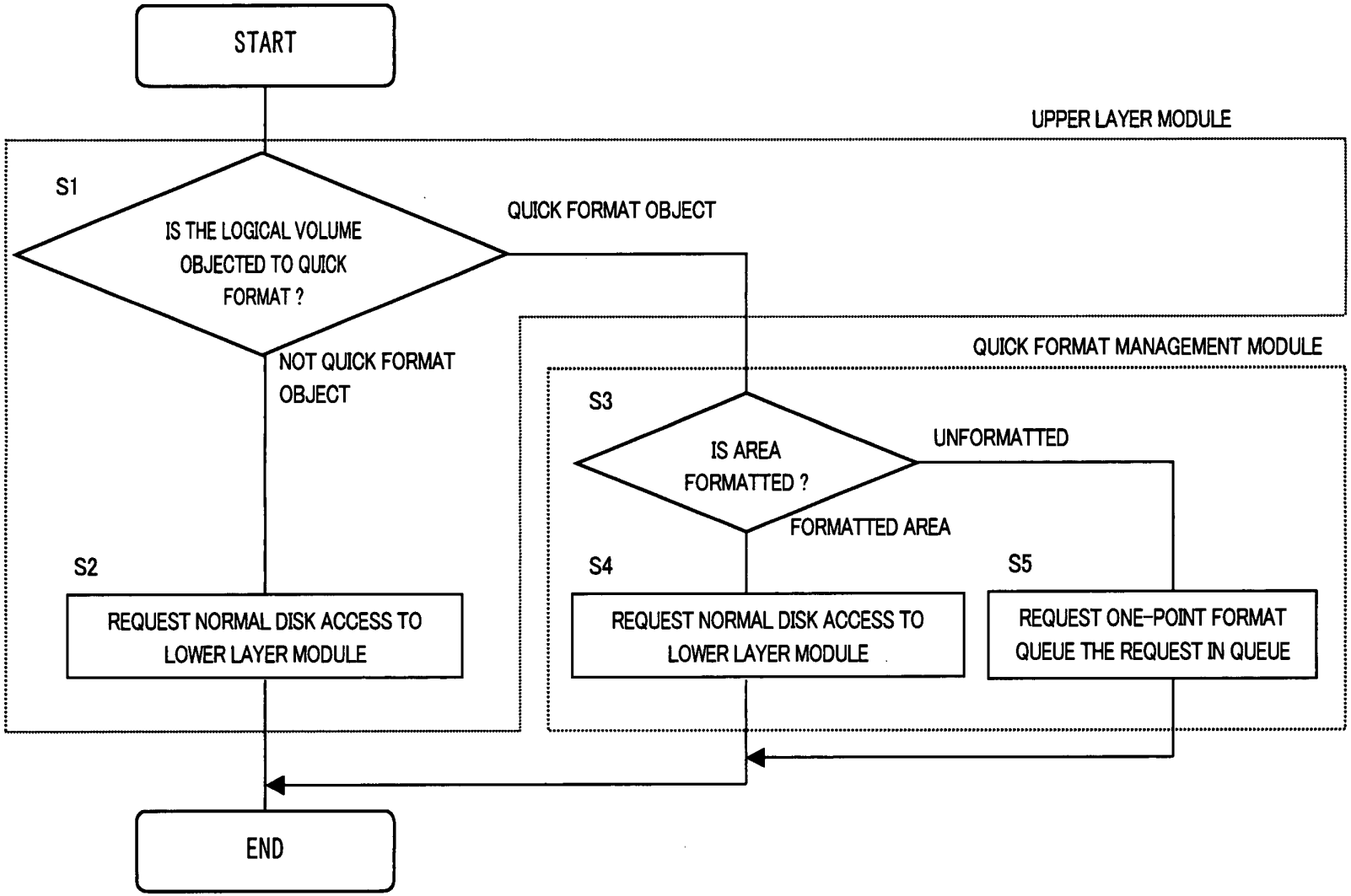

START
UPPER LAYER MODULE
S1
IS THE LOGICAL VOLUME OBJECTED TO QUICK FORMAT ?
QUICK FORMAT OBJECT
NOT QUICK FORMAT OBJECT
QUICK FORMAT MANAGEMENT MODULE
S3
IS AREA FORMATTED ?
UNFORMATTED
FORMATTED AREA
S2
REQUEST NORMAL DISK ACCESS TO LOWER LAYER MODULE
S4
REQUEST NORMAL DISK ACCESS TO LOWER LAYER MODULE
S5
REQUEST ONE-POINT FORMAT QUEUE THE REQUEST IN QUEUE
END

FIG. 7

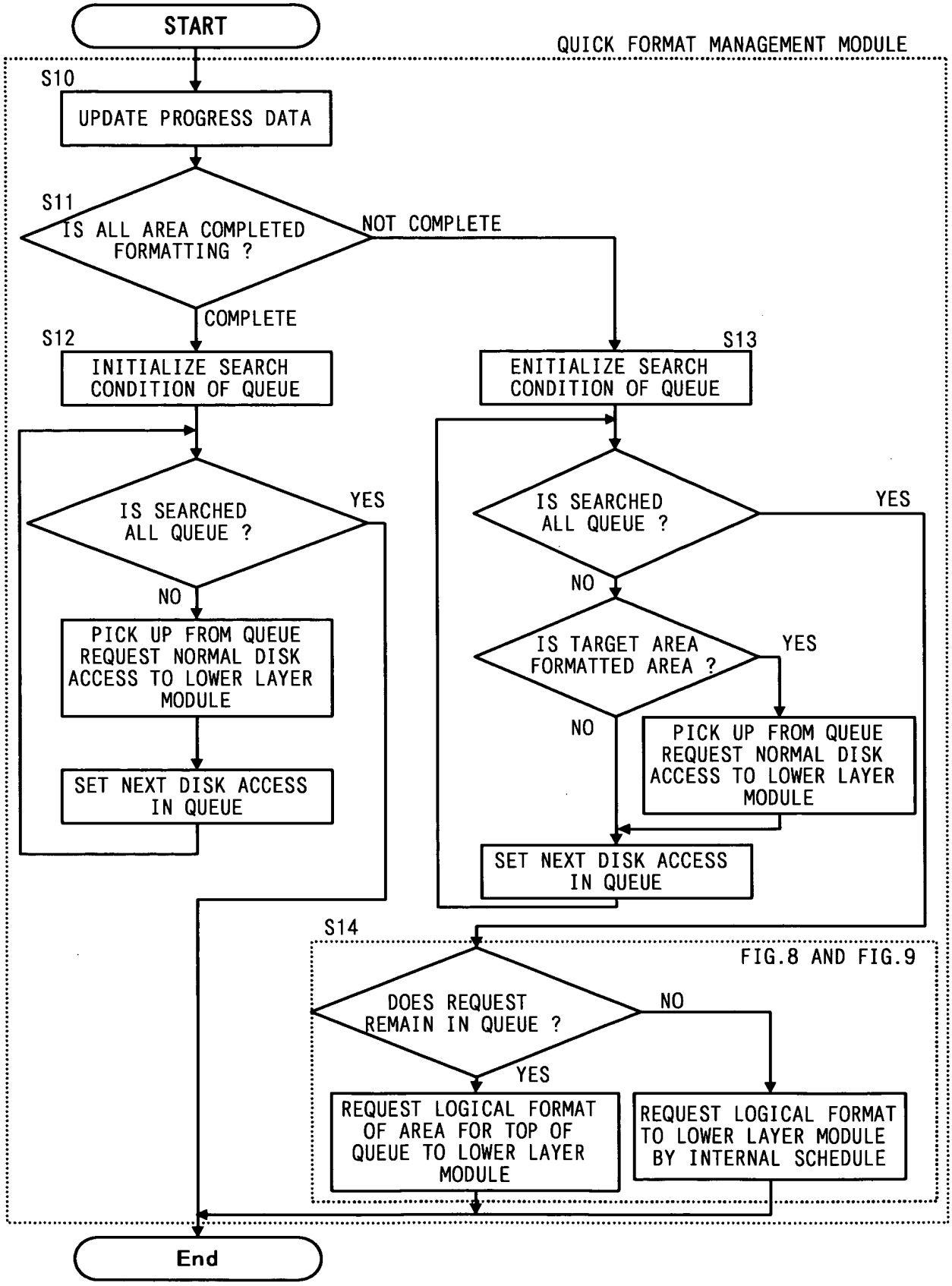

START
QUICK FORMAT MANAGEMENT MODULE
S10
UPDATE PROGRESS DATA
S11
IS ALL AREA COMPLETED FORMATTING ?
NOT COMPLETE
COMPLETE
S12
INITIALIZE SEARCH CONDITION OF QUEUE
S13
ENITIALIZE SEARCH CONDITION OF QUEUE
IS SEARCHED ALL QUEUE ?
YES
NO
PICK UP FROM QUEUE REQUEST NORMAL DISK ACCESS TO LOWER LAYER MODULE
SET NEXT DISK ACCESS IN QUEUE
IS SEARCHED ALL QUEUE ?
YES
NO
IS TARGET AREA FORMATTED AREA ?
YES
NO
PICK UP FROM QUEUE REQUEST NORMAL DISK ACCESS TO LOWER LAYER MODULE
SET NEXT DISK ACCESS IN QUEUE
S14
FIG.8 AND FIG.9
DOES REQUEST REMAIN IN QUEUE ?
NO
YES
REQUEST LOGICAL FORMAT OF AREA FOR TOP OF QUEUE TO LOWER LAYER MODULE
REQUEST LOGICAL FORMAT TO LOWER LAYER MODULE BY INTERNAL SCHEDULE
End

FIG. 8

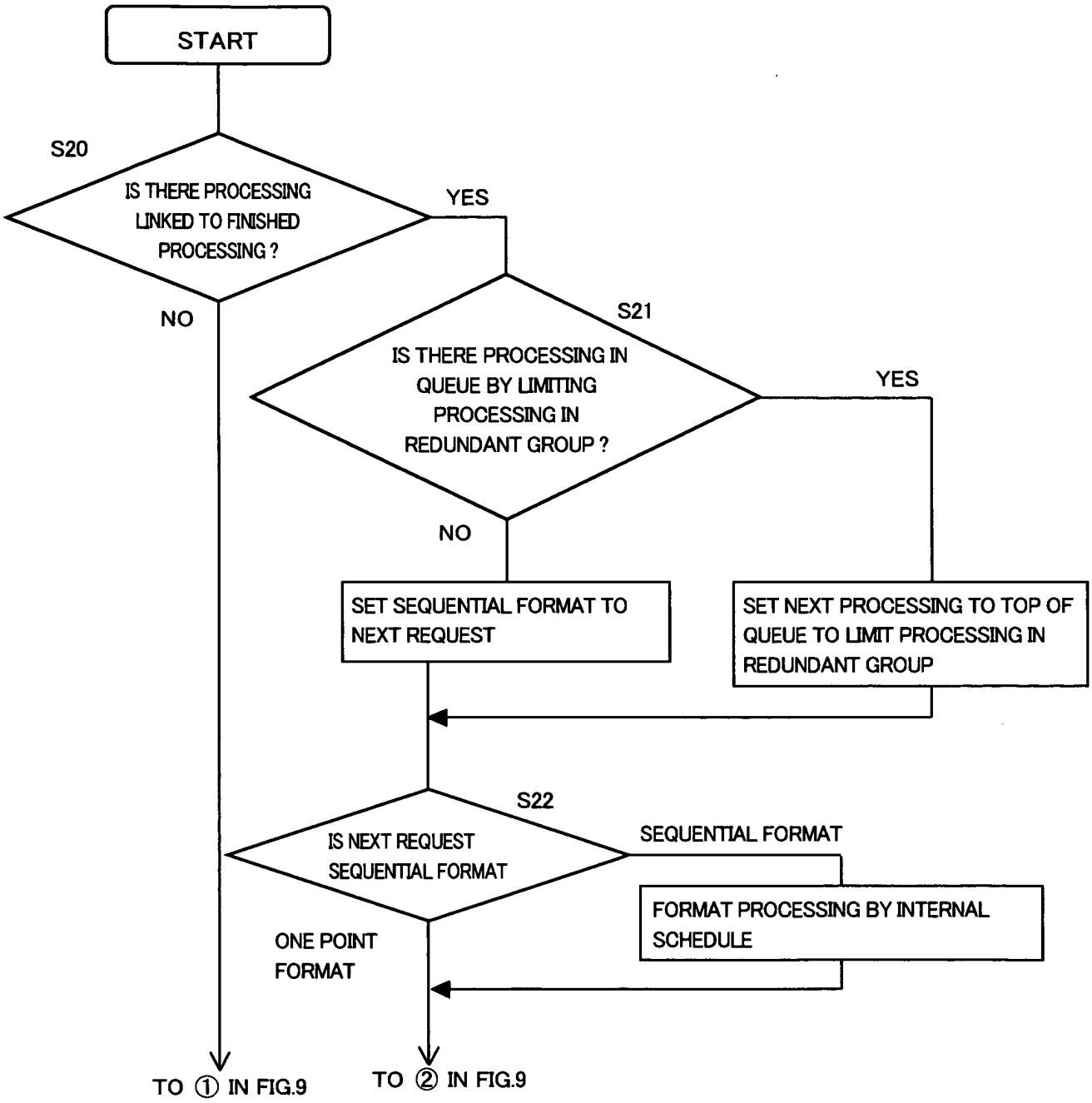

START
S20
IS THERE PROCESSING LINKED TO FINISHED PROCESSING ?
YES
NO
S21
IS THERE PROCESSING IN QUEUE BY LIMITING PROCESSING IN REDUNDANT GROUP ?
YES
NO
SET SEQUENTIAL FORMAT TO NEXT REQUEST
SET NEXT PROCESSING TO TOP OF QUEUE TO LIMIT PROCESSING IN REDUNDANT GROUP
S22
IS NEXT REQUEST SEQUENTIAL FORMAT
SEQUENTIAL FORMAT
FORMAT PROCESSING BY INTERNAL SCHEDULE
ONE POINT FORMAT
TO ① IN FIG.9
TO ② IN FIG.9

FIG. 9

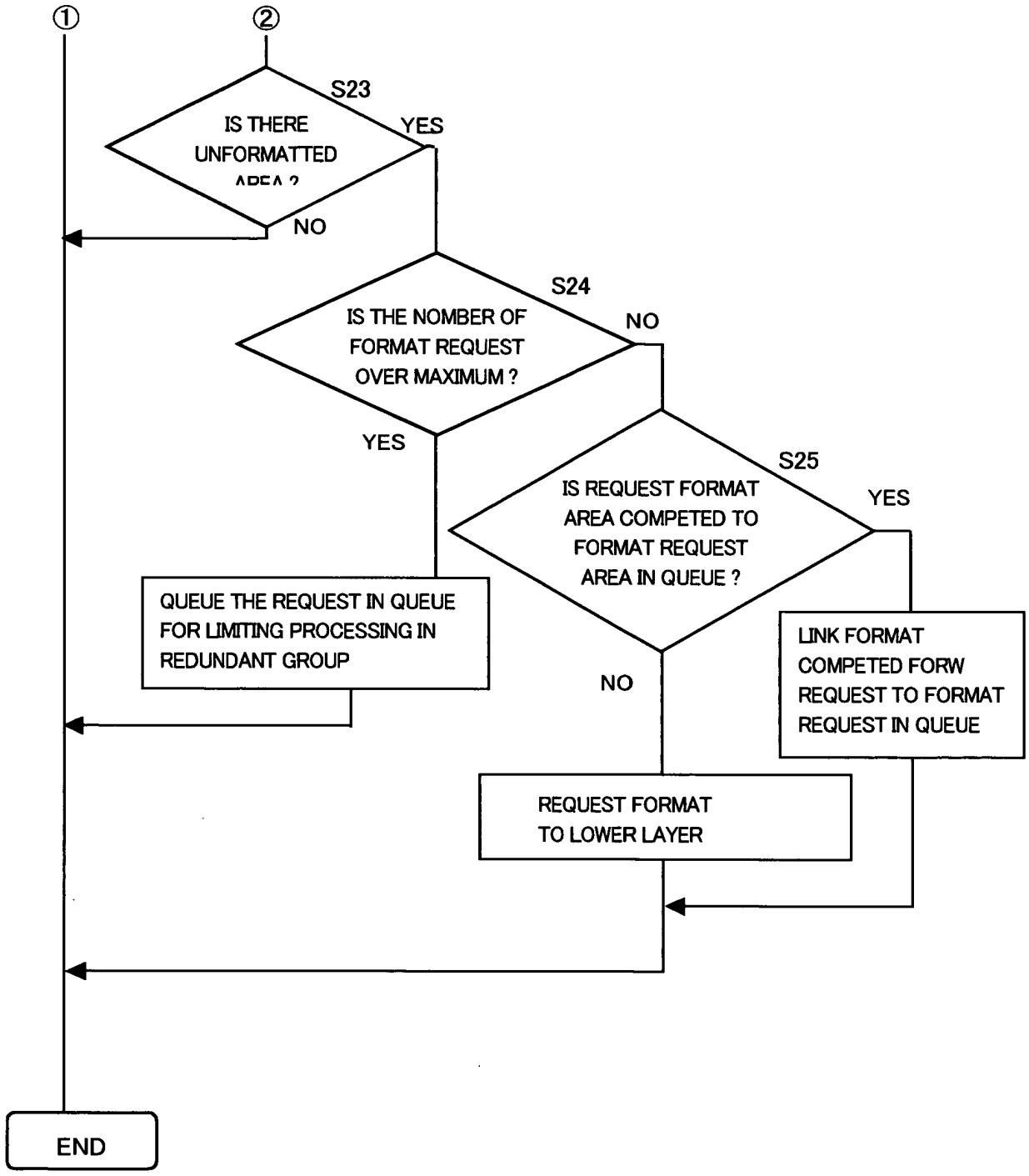

①
②
S23
IS THERE UNFORMATTED AREA ?
YES
NO
S24
IS THE NOMBER OF FORMAT REQUEST OVER MAXIMUM ?
NO
YES
S25
IS REQUEST FORMAT AREA COMPETED TO FORMAT REQUEST AREA IN QUEUE ?
YES
NO
QUEUE THE REQUEST IN QUEUE FOR LIMITING PROCESSING IN REDUNDANT GROUP
LINK FORMAT COMPETED FORW REQUEST TO FORMAT REQUEST IN QUEUE
REQUEST FORMAT TO LOWER LAYER
END

FIG. 10

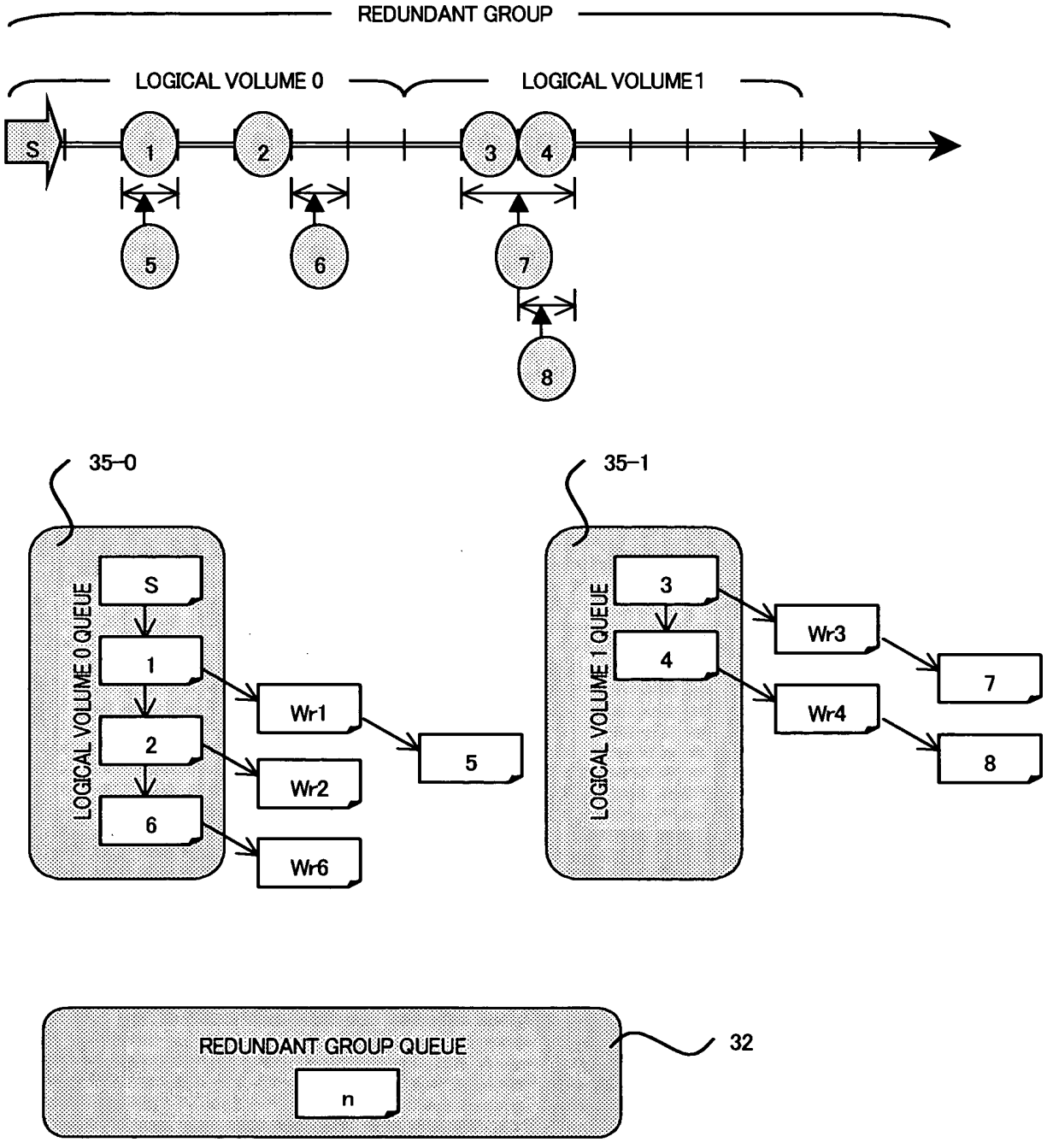

REDUNDANT GROUP
LOGICAL VOLUME 0
LOGICAL VOLUME 1
S
1
2
3
4
5
6
7
8
35-0
LOGICAL VOLUME 0 QUEUE
S
1
2
6
Wr1
Wr2
Wr6
5
35-1
LOGICAL VOLUME 1 QUEUE
3
4
Wr3
Wr4
7
8
REDUNDANT GROUP QUEUE
n
32

FIG. 11

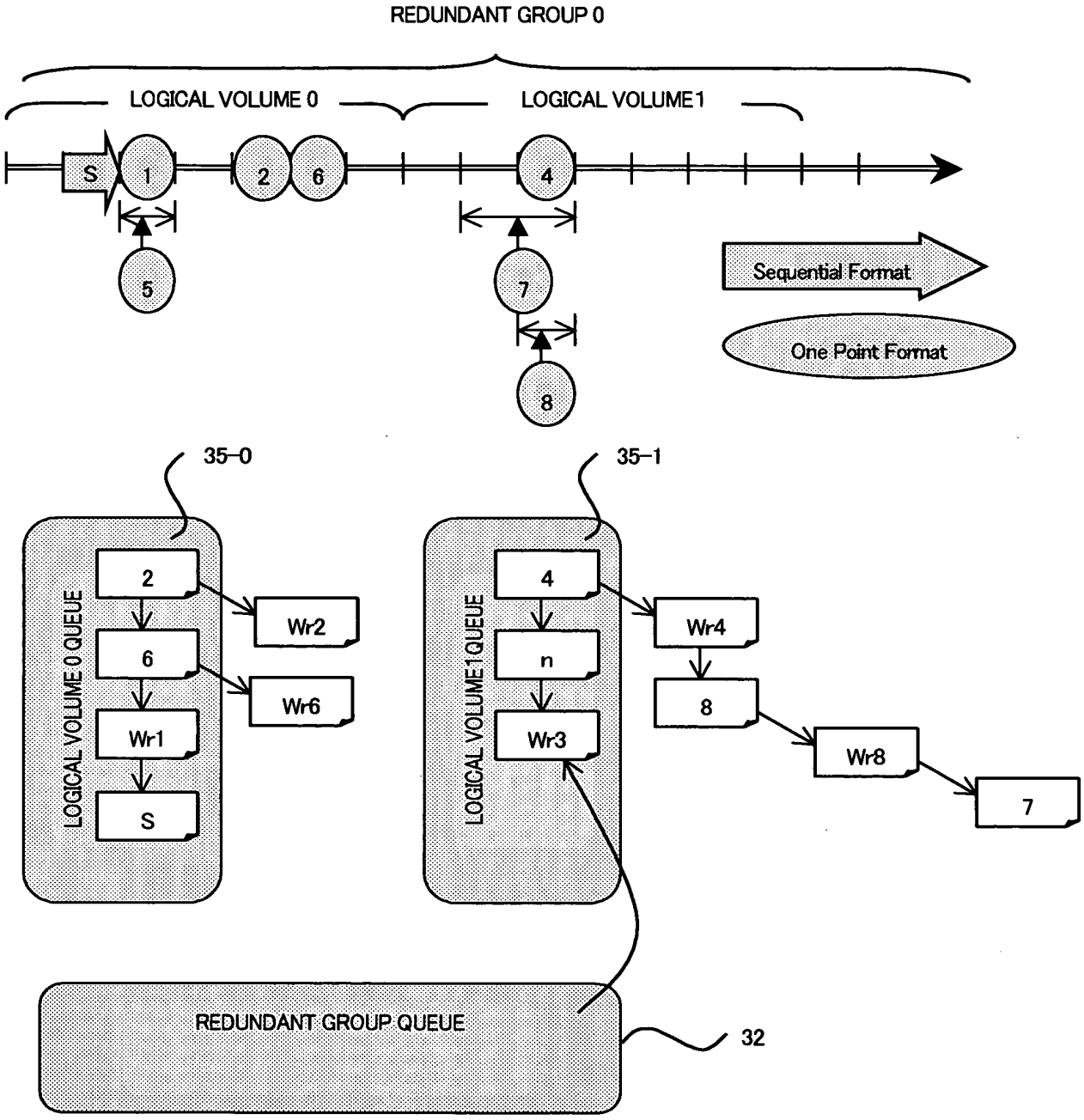

REDUNDANT GROUP 0
LOGICAL VOLUME 0
LOGICAL VOLUME1
S
1
2
6
4
5
7
8
Sequential Format
One Point Format
35-0
35-1
LOGICAL VOLUME 0 QUEUE
LOGICAL VOLUME1 QUEUE
2
6
Wr1
S
Wr2
Wr6
4
n
Wr3
Wr4
8
Wr8
7
REDUNDANT GROUP QUEUE
32

FIG. 12

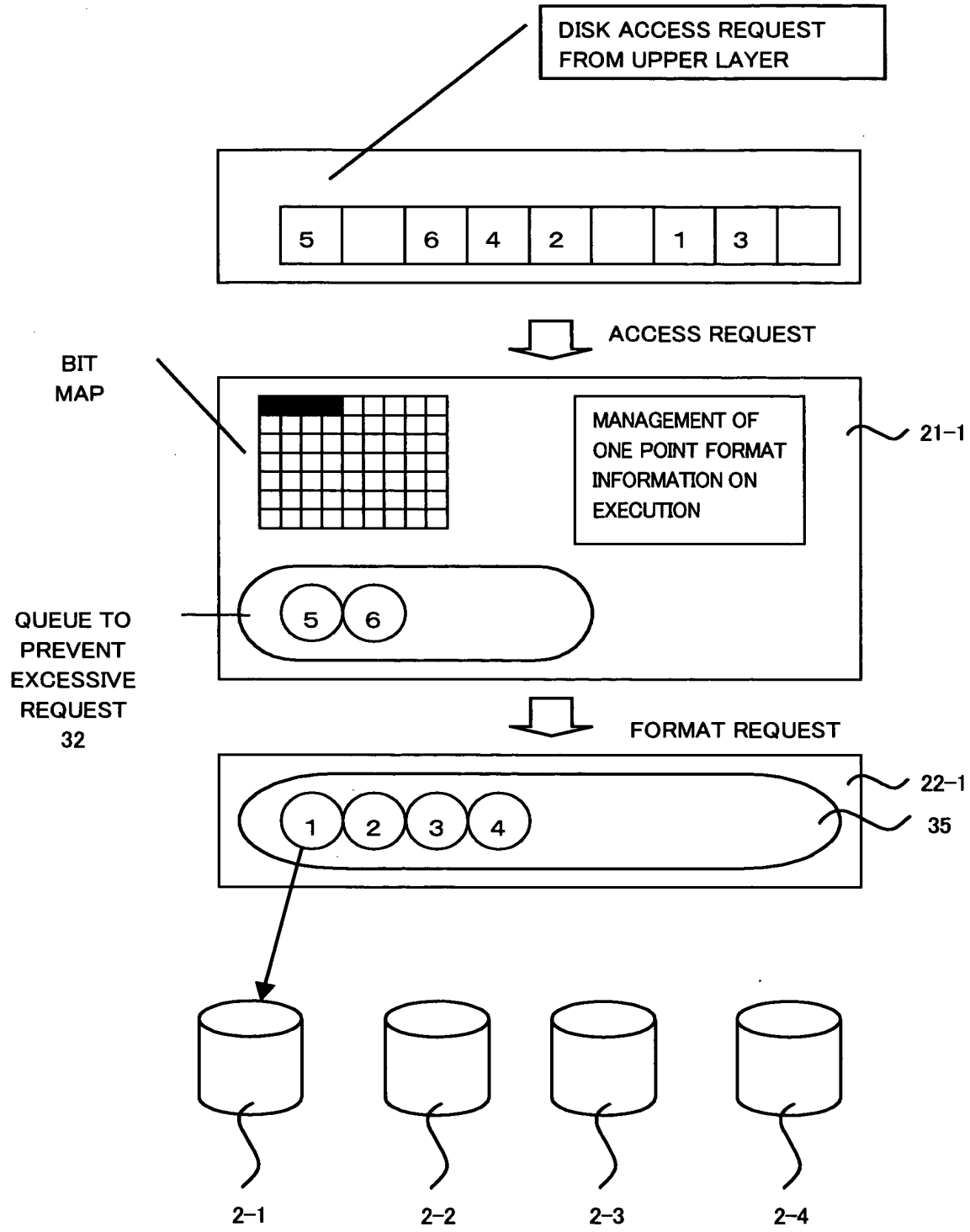

DISK ACCESS REQUEST FROM UPPER LAYER
5
6
4
2
1
3
ACCESS REQUEST
BIT MAP
MANAGEMENT OF ONE POINT FORMAT INFORMATION ON EXECUTION
21-1
QUEUE TO PREVENT EXCESSIVE REQUEST 32
5
6
FORMAT REQUEST
22-1
35
1
2
3
4
2-1
2-2
2-3
2-4

FIG. 13

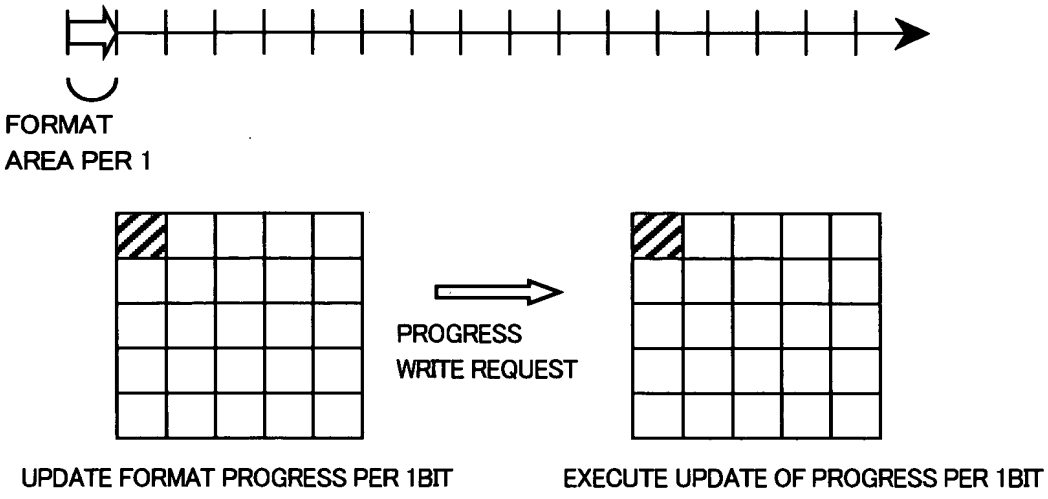

FORMAT
AREA PER 1
PROGRESS
WRITE REQUEST
UPDATE FORMAT PROGRESS PER 1BIT
EXECUTE UPDATE OF PROGRESS PER 1BIT

FIG. 14

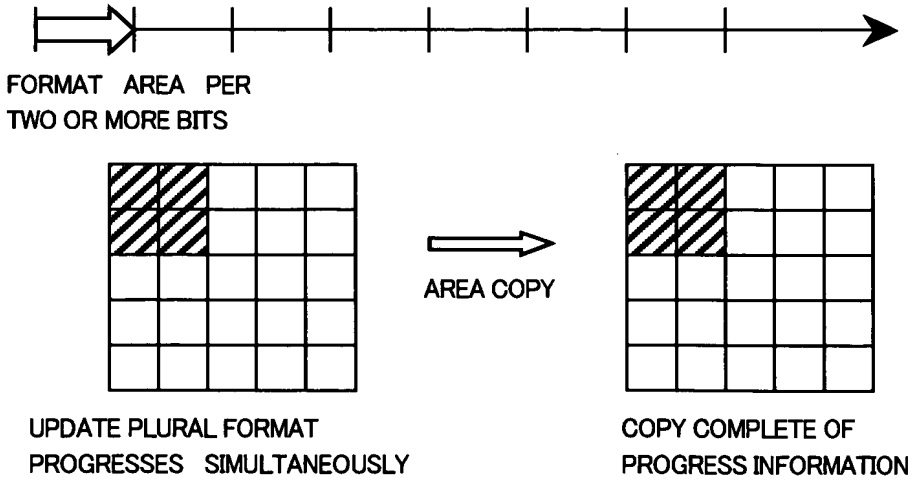

FORMAT AREA PER
TWO OR MORE BITS
AREA COPY
UPDATE PLURAL FORMAT
PROGRESSES SIMULTANEOUSLY
COPY COMPLETE OF
PROGRESS INFORMATION

FIG. 15

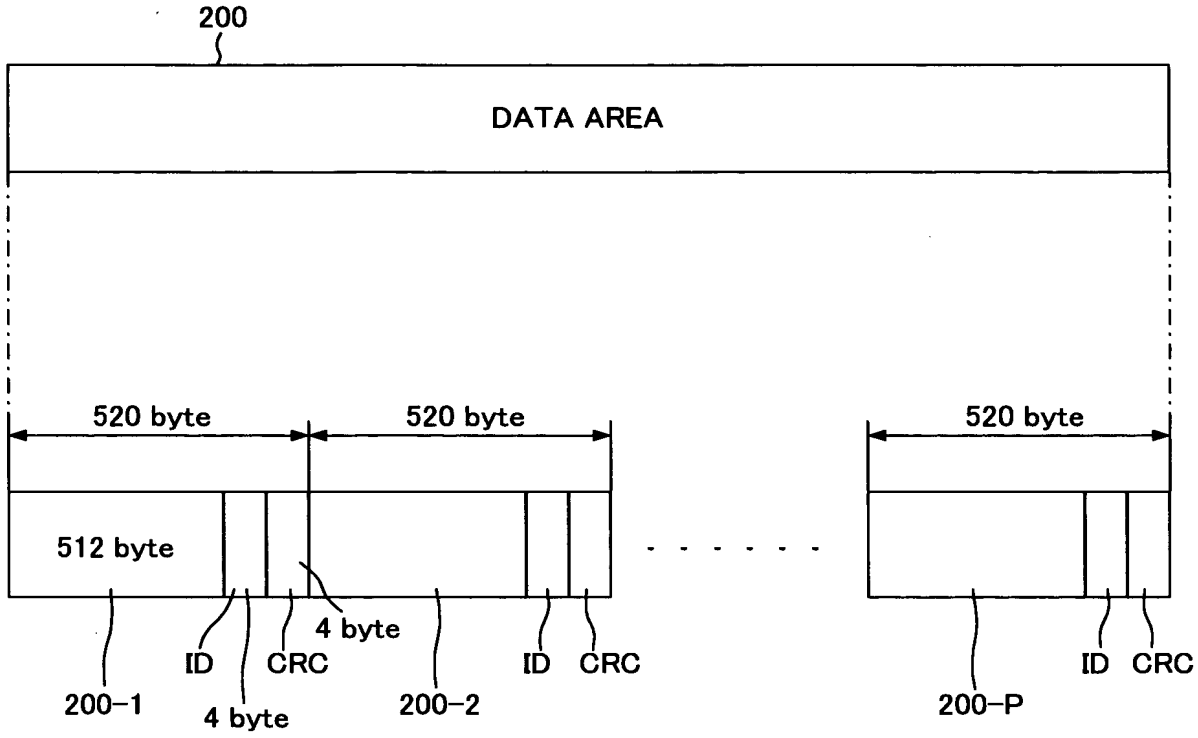

200
DATA AREA
520 byte
520 byte
520 byte
512 byte
4 byte
ID
CRC
ID
CRC
ID
CRC
200-1
4 byte
200-2
200-P

FIG. 16

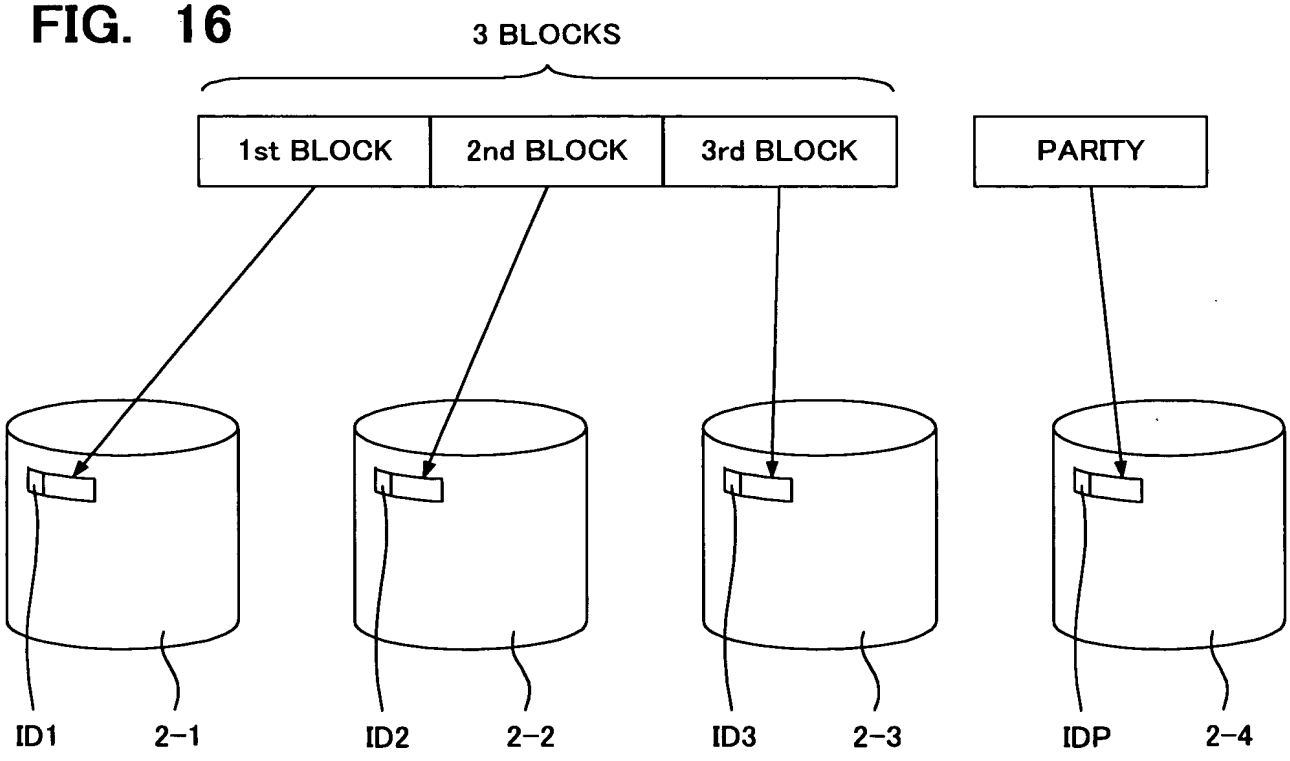

3 BLOCKS
1st BLOCK
2nd BLOCK
3rd BLOCK
PARITY
ID1
2-1
ID2
2-2
ID3
2-3
IDP
2-4

FIG.17

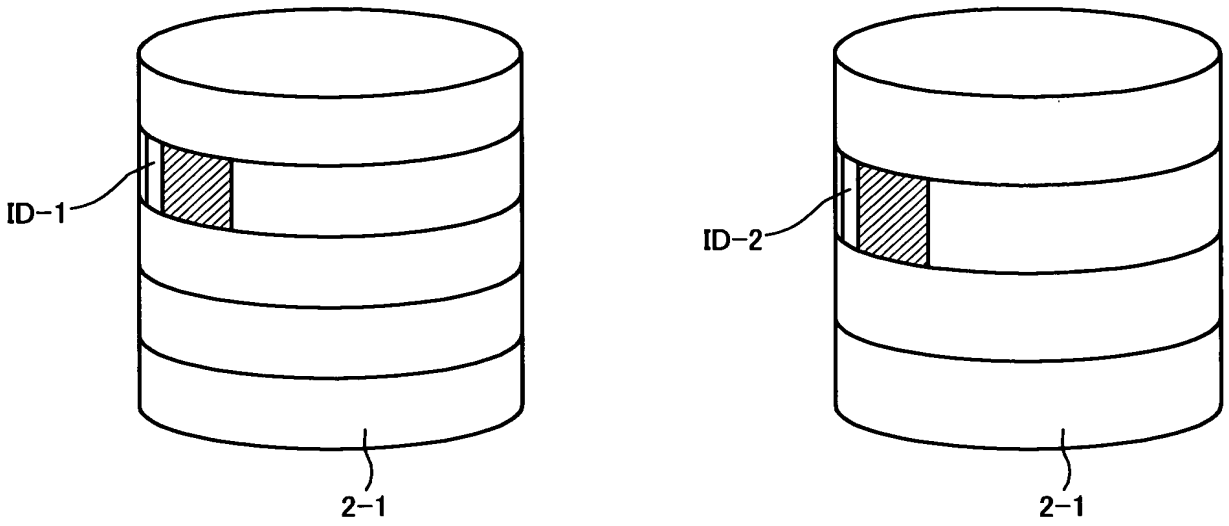


FIG. 18

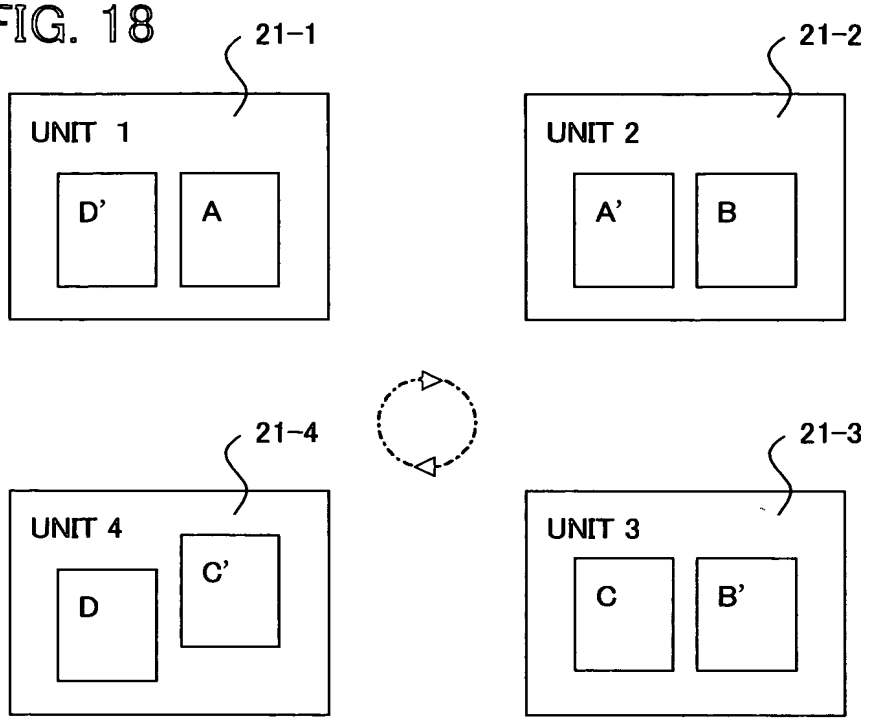


FIG 19

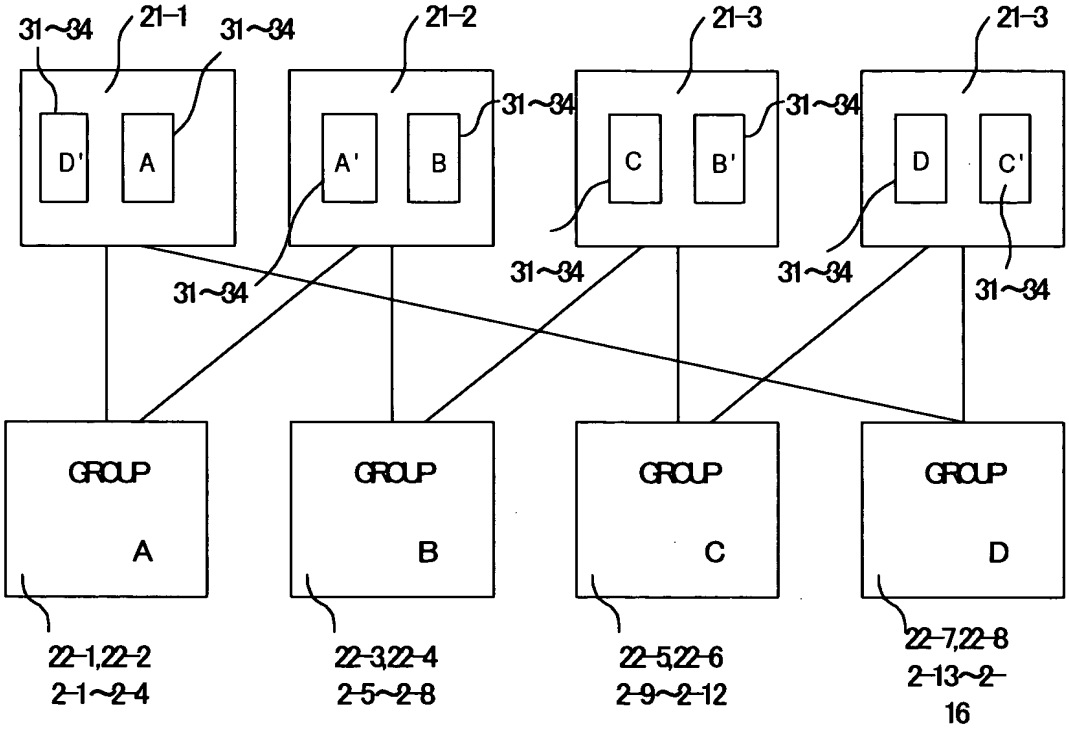

31~34
21-1
31~34
21-2
21-3
21-3
D'
A
A'
B
C
B'
D
C'
31~34
31~34
31~34
31~34
31~34
GROUP
A
GROUP
B
GROUP
C
GROUP
D
22-1,22-2
2-1~2-4
22-3,22-4
2-5~2-8
22-5,22-6
2-9~2-12
22-7,22-8
2-13~2-16

FIG 20

36

| REDUNDANCY GROUP | UNIT | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| A | Active | Spare | No | No |
| B | No | Active | Spare | No |
| C | No | No | Active | Spare |
| D | Spare | No | No | Active |

FIG. 21

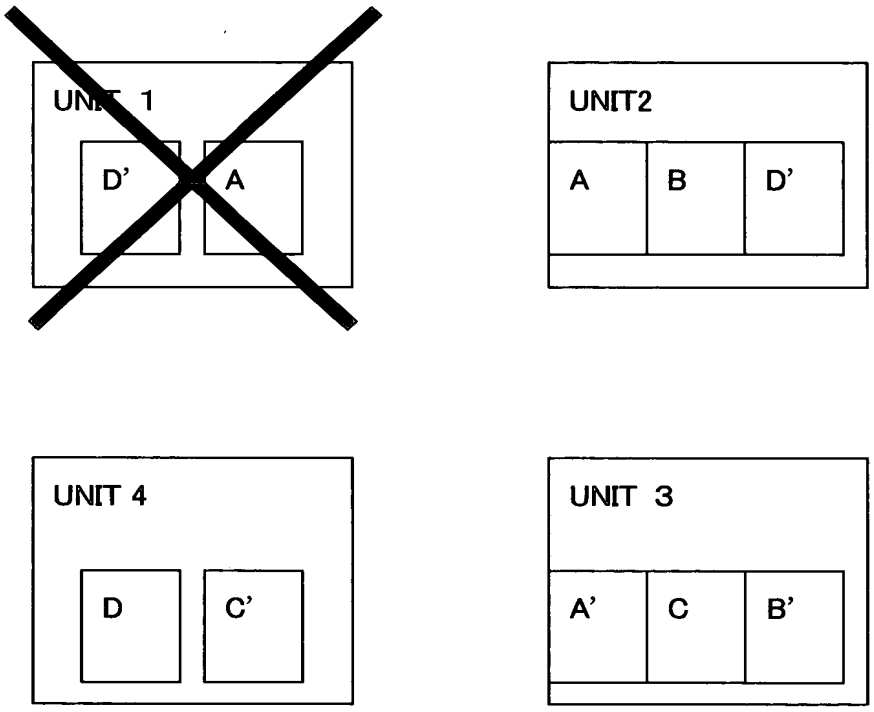


FIG 22

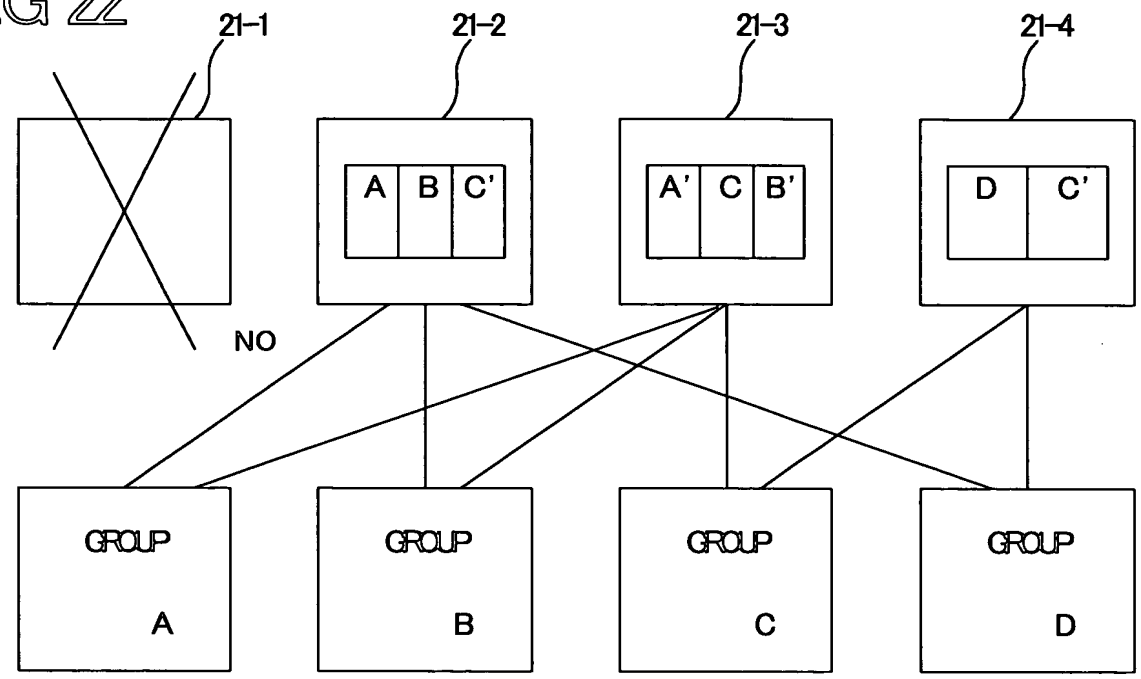
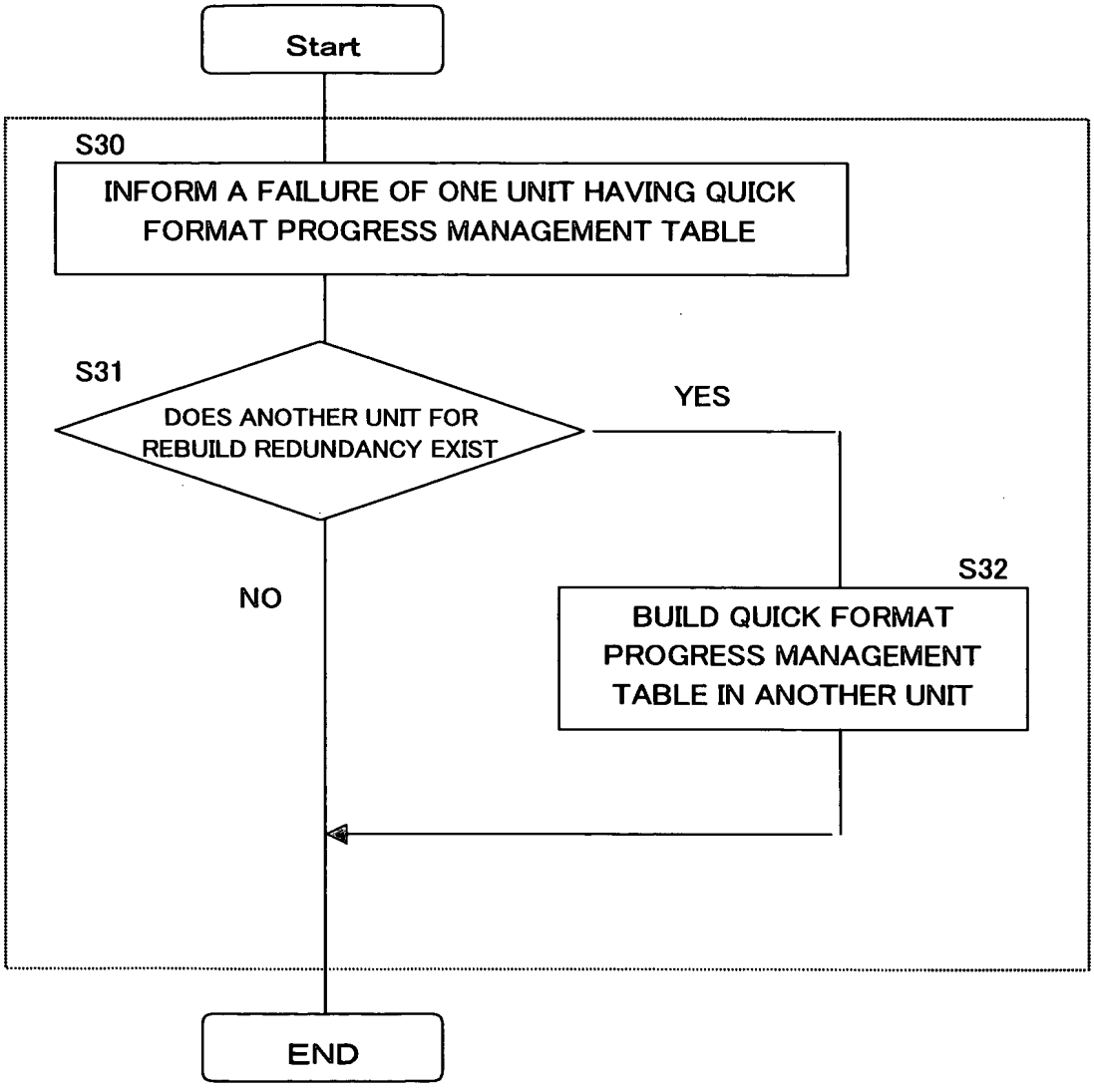


FIG. 23

36

| REDUNDANCY GROUP | UNIT | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| A | No | Active | Spare | No |
| B | No | Active | Spare | No |
| C | No | No | Active | Spare |
| D | No | Spare | No | Active |

FIG. 24


Start
S30
INFORM A FAILURE OF ONE UNIT HAVING QUICK FORMAT PROGRESS MANAGEMENT TABLE
S31
DOES ANOTHER UNIT FOR REBUILD REDUNDANCY EXIST
YES
NO
S32
BUILD QUICK FORMAT PROGRESS MANAGEMENT TABLE IN ANOTHER UNIT
END